USE OF AGAR SAMPLES TO MIMIC THE ELECTROMECHANICAL PROPERTIES OF HUMAN BURN SKIN

Robin Mathieu (1,2), Emilien Schall, (1,2,3), Adrien Baldit (1,2), Anne-Sophie Bonnet (1,2), Marie-Reine Losser (3,4) and Serge Le Tacon (4)

1. LEM3-UMR-7239, CNRS - Université de Lorraine - Arts et Métiers ParisTech, France; 2. ENIM, Université de Lorraine, France; 3. INSERM U1116-DCAC, Université de Lorraine, France; 4. Centre Hospitalier Régional Metz-Thionville, France

Introduction

Burn-related injuries account for 300000 deaths per year [1]. The complications related to burn injuries are hard to predict depending on the burn depth degree. The accuracy of a clinical assessment of a burn wound has been estimated between 50% and 80% [2]. Adequate identification of burn depth is essential to choose appropriate treatments. The electromechanical coupling within soft biological tissues appears to be a promising physical phenomenon for such discrimination [3]. Before clinical investigations, it is of major interest to find a substitute mimicking the electromechanical response of burn skin to validate this assumption. The aim of the present study is to test agar gel as a handy candidate especially for its easy tuning [4].

Methods

Standard compression tests have first been performed with a universal tensile machine (Zwicky0.5) equipped with a 10N load cell on 8mm diameters agar cylinders to assess its mechanical properties. Then indentation test has been conducted for the electromechanical experiments as it is a sound in-vivo technique [5]. Two contacts are required for electrical assessments, so a double spherical indenter has been developed to avoid stress concentration at contact edges. Electromechanical response has been measured in term of force and electrical resistance as function of displacement using the same tensile machine as for the mechanical tests. 6mm diameter spherical indenters were driven with a 0.01mm/s velocity to satisfy quasi-static conditions and reduce viscous effects.

Results

Mechanical response of Agar gel obtained through the standard compression was consistent with the literature [2, 4]. The electrical resistance R appeared to have an exponential shape with respect to the indentation depth x, as presented in Fig 1a over 9 tests. Its behavior has been fitted with the following equation:

$$R = Ae^{-x/B}+C \qquad (1)$$

This equation led to an estimation of the average final resistance of $C = 14.93 \pm 2.71 k\Omega$ for a characteristic displacement of $B = 0.39 \pm 0.05 mm$ and a variation of resistance $A = 52.35 \pm 11.65 k\Omega$. The measurements were performed counter clockwise as it appears on Fig 1b. The value of C increased as function of time translating a water loss.

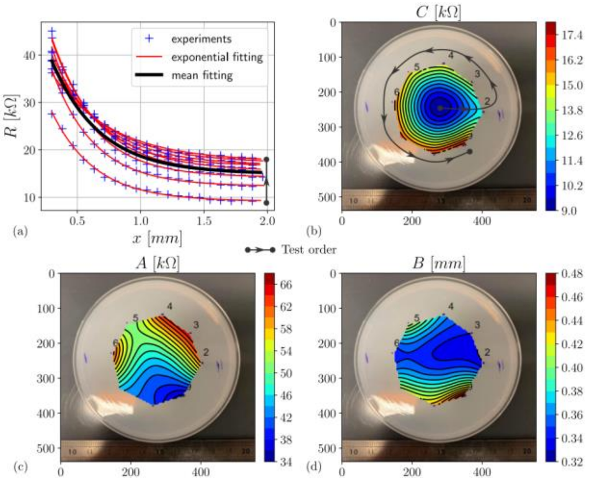

Figure 1: a) resistance-time curves of 9 tests with superimposed in red the fitting of equation (1) as well as its mean value in black. b), c) and d) are respectively A, B and C parameter fields with on b) the test order as function of time.

Discussion

While presenting an asymptotic behavior, the electrical resistance was depth and time dependent, pointing out consistent values as well as dehydration effect. Then, the characteristic depth B implies a 1.95mm displacement to reach a steady regime. Agar biphasic composition could allow reproducing the burn wound deprived of stratum corneum protection as this latter provides resistance up to $M\Omega$. Current investigations are aiming to explore on electrical properties tuning. Meanwhile, techniques are developed to measure in vivo the electrical response in burn wounds.

References

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